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REMARKS

Claims 8-11, 15-23, 26-27 and 29-37 are pending in this application.

Claims 29, 32, 34 and 35 are objected to.

Claims 8-11, 15-23, 26-27, 30-31, 33 and 36-37 are rejected.

The office action dated March 9, 2005 indicates that base claim 18 is rejected under 35 U.S.C. §102(b) as being anticipated by Yokata U.S. Patent No. 5,905,530; and that base claim 8 is rejected under 35 U.S.C. §103(a) as being unpatentable over Wober U.S. Patent No.5,475,769 in view of Yokata. These rejections are respectfully traversed.

Base claim 18

Claim 18 recites a method of generating a linear operator for demosaicing of a digital image by a digital camera. The method comprises accessing a parametric image capture description; measuring parameters of the camera; and using the parametric description and the measured parameters to obtain coefficients of the linear operator.

Demosaicing involves generating an output image having full color information at each pixel from an undersampled image having less than full color information at each pixel. For example, an image sensor of a digital camera generates an undersampled image having only one of red, blue and green information at each pixel. Demosaicing may be performed on the undersampled image to produce an output image having red, green **and** blue information at **each** pixel. A linear operator allows the demosaicing to be performed by convolution.

Yokata discloses a method of correcting an image for distortional aberration caused by a photographic lens (col. 7, lines 20-23). The distortional aberration correction involves storing an image at step S1. Col. 6, line 65 to col. 7, line 5 of Yokata is silent about whether the image is undersampled.

At steps S2-S5, lens position and object distance are determined, and addresses of distorted pixels are determined (col. 7, lines 16-55). At step S6, the distorted pixels are corrected by linear interpolation (column 7, lines 56-60).

Yokata is not remotely related to demosaicing. Yokata does not teach or suggest demosaicing, let alone demosaicing by a linear operator. Yokata does not teach, hint or remotely suggest a method of generating a linear demosaicing operator that can be used for demosaicing.

The office action observes that "linear interpolation encompasses coefficients of the linear operator since in order for linear interpolation to function, coefficients of the linear interpolation must be obtained. The observation is irrelevant, for Yokata's alleged coefficients are not used for demosaicing.

The analysis in the office action is flawed. The office action suggests that linear interpolation and demosaicing are one in the same. This is incorrect, as discussed above. Moreover, demosaicing is not necessarily a linear operation. Claim 18 happens to recite a linear demosaicing operator. If the examiner insists that linear interpolation and demosaicing are one in the same, he is respectfully requested to support his position with objective evidence (not an unsubstantiated opinion).

The office action states that the data table 105 may contain a parametric image capture description. However, this is pure speculation. Yokata simply states that the table 105 may contain "the coefficient of a function which approximates the amount of distortional aberration (col. 7, lines 27-32). Yokata does not elaborate further. Moreover, Yokata does not suggest that this so-called description is parameterized.

The office action states that the table 105 is used at step S6 to produce coefficients for linear interpolation. This is incorrect. The table 105 is used at step S4 to determine the addresses of distorted pixels (col. 7, lines 24-28).

Thus, Yokata does not teach or suggest a method of producing a linear demosaicing operator, let alone the method recited in claim 18. Therefore, claim 18 and its dependent claims 19-20, 26-27 and 29-37 should be allowed over Yokata alone.

Yokata is not even analogous art according to the MPEP.[1] The field of applicant's endeavor is generating images having full color information from undersampled digital images. Yokata's endeavor is correcting aberrational distortion caused by photographic lenses. Yokata is not pertinent to the particular problem with which the applicant is concerned, which is generating a linear demosaicing operator. For this additional reason, claim 18 and its dependent claims 19-20, 26-27 and 29-37 should be allowed over Yokata.

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1 See MPEP 2141.01(a). "In order to rely on a reference as a basis for rejection of an applicant's invention, the reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the inventor was concerned."

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Base claim 8

Claim 8 recites a method of processing an input digital image produced by an optical system. The input image has less than full color information at each of a plurality of pixels. The method comprises accessing an operator including an array of demosaicing weights. Values of the weights are determined from measured parameters of the optical system and a model of the optical system. The method of claim 8 further comprises applying the operator to the input image to produce an output image having full color information at each of a plurality of pixels.

Wober et al. compute optimal coefficients using a known test pattern. The test pattern is captured by a digital camera, which provides a mosaic image. Then an optimum set of coefficients is calculated by minimizing the squared difference between the image of the known test pattern and a third image (the third image is obtained by linearly demosaicing the mosaic image with that set of coefficients).

Wober et al.'s linear demosaicing approach is summarized at col. 2, lines 25-35 and in particular by the equation at line 26. The equation at line 26 is A*W=X, where A is a matrix of neighborhood values acquired by a camera, X is a vector representing a single pixel, and W is a matrix that contains weighting coefficients. Thus, the equation at line 26 computes a single value (X) in the third image. The location of the pixel (X) in the third image corresponds to the central pixel of the neighborhood (matrix A). The matrix W is slid across the image of the known test pattern to compute additional pixels of the third image.

Wober et al. solve for the coefficients in matrix W using linear minimum mean square error (LMMSE) between the image of the known test pattern and the linear demosaicing of its corresponding mosaic image (i.e., the third image). The matrix W is applied to each of the pixels in the image of the known test pattern, and a set of coefficients for matrix W is computed that is best in an LMMSE sense) for all of the pixels.

Thus, Wober et al. offer an example/training-based approach, where matrix W is trained using the known test pattern as an example. Wober et al. do not assume to know anything about the forward process of how a camera captures an image. No information about the image capture process or the camera is used. The camera and the image capture process are treated as a black box.

The office action contends that Yokata suggests modifying Wober's demosaicing method to produce the method of claim 8. However, Yokata is totally silent about demosaicing. It is not even analogous art.

Yokata does not teach or suggest that aberration correction can be combined with demosaicing. Yokata discloses standalone processing to correct for aberrations caused by zoom operations.

Yokata provides no guidance whatsoever for modifying Wober's example/training-based method to produce a method that is based on measured parameters and a model of an optical system. As indicated above, Yokata does not teach or suggest a model-based approach. Yokata simply interpolates between measurements of images at different zoom positions.

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On page 5, the office action makes the following statement in support of the '103 rejection.

> Wober does not teach that values of the weights are determined from measured parameters of the optical system and a model of the optical system. However, Wober suggests that the accuracy of the coefficients to interpolate color values depends on the amount of overlap between spectral sensitivity ranges of the individual color filter elements in the mosaic pattern as well as the amount of lens blurring and the actual arrangement of the color filter within the mosaic pattern, and if the residual error is found to be unacceptable then any of the aforementioned parameters can be adjusted either alone or in combination to reduce the residual error (Wober, col. 7, lines 14-22). In other reference, Yokota teaches that a linear interpolation of a color image is implemented by taking measured parameters of an optical system (i.e., zoom data, focus data) and a model of the optical system (i.e., distortion model of the lens; Figs. 6-12) into consideration to produce a higher quality image. See Yokota, Fig. 2; col. 7, lines 5-60 and col. 15, lines 40-45.

The statement is incorrect about an optical model being shown in Figures 6-12. Figures 6a-6c merely illustrate a relationship between distortion and different zoom positions (col. 9, lines 18-20). Figures 7-11 merely illustrate how distortion is corrected. Figure 12 is a cross sectional view of a lens, suitable for image correction.

The office action does not address issues such as how a person skilled in the art would integrate the teachings of Yokata with the teachings of Wober, or why one would even want to integrate the teachings. It is also not clear why integrating the teachings would produce a higher quality image. One can speculate as to why. However, speculation does not form a proper basis for a '103 rejection.

The combination of Wober et al and Yokata does not produce the method of claim 8. Therefore, claim 8 and its dependent claims 9-11, 15-17 and 21-23 should be allowed over the combination of Wober et al. and Yokata.

The examiner is respectfully requested to withdraw the rejections of the claims and issue a notice of allowability. The examiner is encouraged to contact applicant's attorney Hugh Gortler to discuss any remaining issues.